

ATLANTIC
LOCOMOTIVE



ATLANTIC *LOCOMOTIVE*

CONSTRUCTION ARTICLES

of a Steam Operated

Coal Fired

Atlantic Locomotive

in $\frac{3}{4}$ " Scale



by

L. D. Friend



YANKEE SHOP

Danvers, Mass.

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ATLANTIC $\frac{3}{4}$ " SCALE

INTRODUCTION

From time to time, I receive inquiries from the railroad brothers, particularly new members, as to what would be the best engine for the amateur to build in live steam. Invariably my answer is the 4-4-2 Atlantic type. There are several reasons why I make this statement.

First, it is a short engine which is built in two sections, locomotive and tender, and can be easily transported in your auto from one club track to another, or to a friend's house, if he happens to have a short track to run it on. It is not too heavy for one man to pick up, and the engine section should not weigh over one hundred to one hundred and fifteen pounds, while the tender will average thirty pounds. Because it is an engine with four driving wheels, there is a minimum amount of machine work to do in completing the engine.

I am writing up this engine in $\frac{3}{4}$ " scale which according to the findings of the Brotherhood of Live Steamers (which covers the United States and Canada) is the most popular scale in the country. Most of the club loops in the country have 3-17/32" gauge track and there are some twelve loops in operation, besides many back yard spurs or short tracks.

Another reason for the small engine is that you would finish the machine work and have this engine operating much quicker than if you were to build a big, long, husky job; and when finished, it should pull at least four men on a level track. Most all live steamers like to build more than one engine. The Atlantic being the first project gives you an engine to operate while you are building that big brute you always admired. Again, it can be turned over to a younger member of the family when the big job is completed.

The cost of an Atlantic, blueprints, castings, and all materials, should be under \$100.00. Spending this amount of money over two or three years, home workshop pleasure,

will give you a hobby which is certainly less expensive than many other hobbies, particularly if you compare it to golf or poker wherein you would invest two, three, or four hundred dollars per year. Because of the continued requests from the brothers to hear more about the Atlantic, I have decided to write the engine up in different sections.

There are two ways of equalizing this engine, both are good; one, by using springs as is done in the prototype, the other, by using solid bars and equalizing the two ends of the springs with each other. By doing the latter, you have what might be called a perfect traction. Whichever way it is constructed, it will be a little different than the prototype and simplifies much of the detail when completed with all gadgets and exterior detail added, it will look like the regular Atlantic. In no case would the average hobbyist build the inner part of the chassis exactly the same as the prototype. It is built for efficiency as well as simplicity in machine work. There are those who actually put wedges in their main driving wheel boxes. In this scale type of engine it is not necessary, it is just superfluous work. There are those who drop down to the tiniest of hexagon bolts such as 0-80 and 2-56 to be sure their engine is the same as the prototype. We much prefer to use 3-48 and 5-40 bolts which are easier to tap, less taps are broken and generally work out just as well.

I decided to put Baker gear on this engine, although the prototype carried Walschaert gear. The reason it was decided to use Baker gear is because of its simplicity. You can lay out the different dimension holes with a pair of dividers, drill and ream these holes, after all of this gear is assembled, you have just as good a working gear as the prototype and the fear of the gear work is over. I have found many live steamers will build up to their valve gear and then get scared to death. Actually, Baker gear is very simple as you will see in later articles written on this subject.

There are further advantages than those enumerated upon for picking this small engine. You have a short boiler,

a good firebox, short tubes to insert, easy accessibility for welding in these tubes. In fact, it is all within the scope of the average man who can, with the help of his friends, plus a couple of blow torches, braze or silver solder this boiler without any difficulty. Again, a further advantage is that the chassis is short and can be finished on small bench machinery very readily, whereas the longer engines or longer chassis you feel as though you should call on some machine shop friend to get the pedestals milled out.

The trailer truck, in this particular case, as constructed, is made separately and then bolted on to the end of the chassis. This again gives one a small piece to work with both for drilling and cutting. Normally, the prototype chassis frame reaches from the tail end of the cab to the front bumper beam, but in this case, I have cut off the chassis frame behind the driving wheels, because the two wheel trailer truck does not have to swing; this greatly simplifies the construction of the model.

One more comment on this construction is that the tender is built first.

Many write me to the effect that they have had no experience on a lathe or drill press. In one case, a live steamer had bought his lathe and had hardly ever seen one before, knew nothing about micrometers, calipers, or how to sharpen tool bits, or what speed to run his drill, or what speeds to use in turning on his lathe. One thing this live steamer did very thoroughly was to read his lathe manual, in fact, as many times is the case, he mentioned things which I had never thought of, having more or less grown up around machinery, habitually doing things by second nature.

In constructing this engine, we will start with the tender first by turning the two sets of four Bettendorf truck wheels. Great caution should be used in drilling the truck side frames; be sure and use a jig so that all four truck side frames will have exactly the same hole dimensions from center to center. This of course, will make the truck run straight on the track instead of staggering from one side to another.

The tank for this tender, is made of brass. Galvanized iron could be used just as readily, but will not appear so well when finished. By the time you come to the construction of the front truck after finishing the tender, it will be relatively simple to get accuracy in your work from previous experience, as you will now be more familiar with your lathe, drill press, and also understand a little better the fundamentals of machine work.

As you come to the construction of the chassis frame, driving wheels, axles, crank pins, and water pump, all will appear to become more simple compared to your first view of the blueprints. Crank pins should be quartered to one thousandth of an inch or closer to turn over correctly. The axle water pump is a necessity as all engines need water, and when they need it, this is the pump which will always produce the water when you want it.



*Yankee Shop
Portion of N.E.L.S. loop showing in background*

Bettendorf Trucks, Tender Frame and Tank

The Bettendorf truck calls for $2\frac{1}{4}$ " wheels on some engines, but on the Atlantic it should be a 2" wheel, pushed on to a $\frac{1}{2}$ " drill rod axle when turned in accordance with the drawing. Castings for this truck can be purchased. The bolster is sprung as you note with two $\frac{3}{8}$ " coil springs under each end of the bolster. This is sufficient springing to take care of the 30 pounds weight which tender, water and coal should weigh.

It is best to make a jig to bore the tender truck frames. This is done so that all four frames will be exactly the same hole dimension from center to center, and therefore, roll properly when on the rails. The axles are made from $\frac{1}{2}$ " drill rod approximately $5\frac{1}{2}$ " long with each end turned to .3755 diameter and the wheels pushed on tightly. The back of one flange to the back of the other flange should measure $3\text{-}9/32$ " with a $3/32$ " flange, $1/8$ " high and a tire $3/8$ " wide. The above sizes are a standard wheel dimension for all $3/4$ " scale wheels.

I have explained many times the simple method of turning wheels with a stud arbor, but perhaps because of new readers, it might be well to cover this point again. First, put your wheel casting in your three jaw chuck, turn off the back face, and shoulder the back of the flange, also take just a little chip on the top of your flange, so that when you turn it around and place it in your chuck again, the wheel will run true. Then, take a cut on the front of your hub, also your rim, cleaning these up to the proper thickness which should be $\frac{1}{2}$ " strong. Before taking it out of the chuck, center drill the wheel, then drill and ream it with a $3/8$ " reamer. Now, you are ready to do the finished turning. This should be done on a stud arbor.

A stud arbor can be made out of any old drill that you happen to have that has a No. 2 taper on it. Anneal the drill so that you can machine it. Cut it off allowing about $1\frac{1}{4}$ " of the straight stock of the drill for a working shoulder. Turn down this shoulder true in your head stock to .375

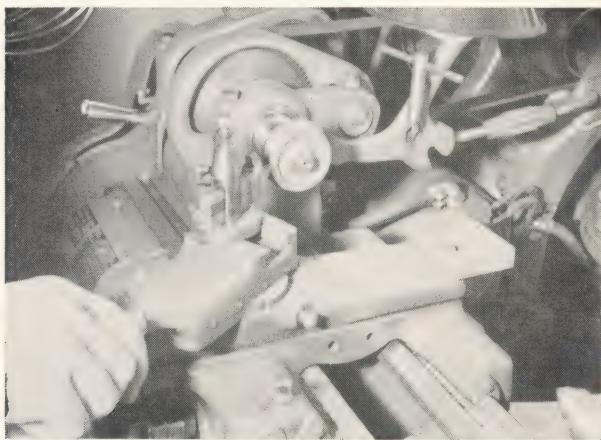
x .375" long. Then, chase a thread of about $\frac{3}{8}$ " on the end of this stud using a S.A.E. thread, fitting it to a nut tightly. After this is done, screw the nut on backwards, take a chip across the face of it. Take the nut off and reverse it, using a true washer behind it to hold your wheel. Now, you have a stud arbor to turn all of your small wheels on. If you wish to turn larger wheels on this same arbor, allow a little longer shoulder, make a nice snug fitting collar to whatever dimension you wish to put on the stud. This simplifies your wheel turning, in that you can work on one set-up and keep changing your wheels, doing one operation on each wheel at a time. You should come out with perfectly true wheels using this method. It is wise to use a micrometer when turning the tire dimension and getting all wheels of a truck exactly the same micrometer diameter.

The bolster can be fitted with a file after the side frames have been placed on the ends of the axles. You will notice by the blueprint that there are in both ends, two small filuster head screws placed in both ends of the bolster to keep the upper ends of the springs in place. Also, two screws are placed directly below the center of the bolster screws in the truck frames, to hold the bottom of the springs in place.

The frame of this tender is a very simple job. The sides are made of $\frac{3}{4}$ " channel iron 15 $\frac{7}{8}$ " long with the rear beam separating the channels; this beam, of course, has the usual coupler pocket. The truck center plate, a casting between the frames, is 7 $\frac{1}{8}$ " long and placed in the frame on 9" centers. The truck center plate should come flush to the top of this frame, so as to allow support for the water tank, also it is a means through which to bolt the tank on to the tender frame. The front cross member of the frame can be any piece of steel you might have— $\frac{3}{4}$ " x 1" x 7 $\frac{3}{8}$ ". This front cross member needs to have a small bolt $\frac{1}{4}$ " — 28 set in the bottom center which carries a draw bar that attaches to the end of the locomotive chassis. The hooks on the side may be of your own design.

You will note in the tender drawing that the tank is a

little shorter than the tender frame. There are angles rivetted to the bottom of the tank on each end, which fasten the tank to the tender frame by screws. Splash boards are shown in the drawing, but are not necessary in a model, unless one likes to put them in, or for the purpose of stiffening the tank. This particular tender is made of $1/32''$ brass plate, but one may use galvanized iron which is easier to get. To improve the appearance of the sides and ends of the tank, you may drill a long series of holes, which you may see in the picture, and place in these holes No. 15 escutcheon pins, these to appear like rivets on the outside. After all the holes have been filled with escutcheon pins of whatever length you may have, clamp a piece of soft pine over the heads of these pins, turn the plate over, cut all the escutcheon pins off flush and file them,—then, take a soldering iron and draw a strip of solder right across these pins to hold them in place. This tender is entirely soldered and does not need rivet construction. However, this row of so-called rivets makes a neat looking appearance on the outside. I do not think much else need be said as the plan is self-explanatory.



Turning 2" Wheel on a Stud Arbor

Front Engine Truck

The front engine truck is of simple design using coil springs instead of leaf springs. This design being originated by early live steamers, who use this type of front engine truck on all engines, as it seems to answer all the difficulties, having a swing bolster and sufficient springing.

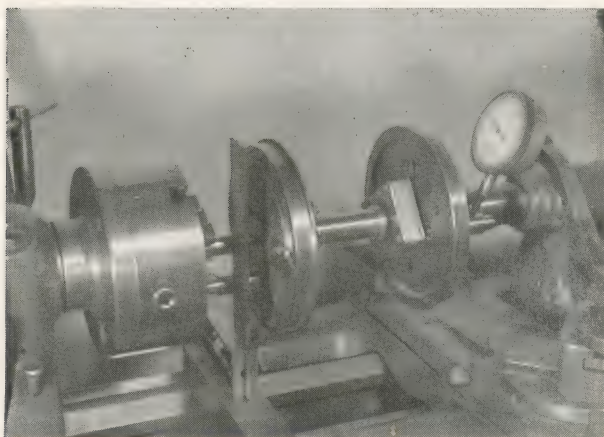
The side frames are made from a piece of $\frac{3}{8}$ " x $1\frac{1}{2}$ " x 7" c.r. steel shaped to the plan with the pedestal slots cut into these frames on $5\frac{1}{4}$ " centers. The cross members you will note, are made of $\frac{1}{2}$ " x $\frac{3}{8}$ " x 3" c.r. steel and notched so that they set on top of the side members, with screws going into the ends of these cross members. Use 6/40 hexagon headscrews on this particular spot.

The equalizers are made of $\frac{1}{16}$ " steel $1\frac{1}{4}$ " wide by 6" long, following the plan for profile with a $\frac{1}{8}$ " x $\frac{3}{8}$ " bar rivetted in the bottom between two of these supporting bars to separate them. When making these equalizers, make all four at the same time. You will note in the bottom of this yoke, there are four round head rivets placed to hold the springs on center, also on the bottom of the side frames are located rivets as well to hold the top of the springs in place.

The swing bolster is made up of two pieces of 1" x 1" x $\frac{1}{8}$ " angle iron rivetted to a piece of $\frac{1}{8}$ " plate. The heart shaped links, or hearts, as they are sometimes called, and of which there are four, are also made of $\frac{1}{8}$ " c. r. steel $\frac{3}{4}$ " wide. These four pieces should all be drilled at one time before filing out the "y" slot, so that all holes will be of equal dimension. These plates hang on the inside of your cross members on $\frac{1}{8}$ " pins, which should come out flush to the edge of the plate, to allow easy action of the bolster to swing sideways. The axle is the usual $\frac{1}{2}$ " drill rod with a $\frac{3}{8}$ " shoulder for your wheel, and in this particular instance we use $2\frac{1}{4}$ " wheels, although the blueprint is drawn to take either 2" or $2\frac{1}{4}$ " wheels. The journal boxes are 1" square cast iron by $\frac{3}{4}$ " long, slotted to fit your side frames. It is well to take great pains in machining these boxes so

that the reamed hole will be in exact center between your slots, together with the fact, that your side frames being made as a pair should both be exactly the same length in the box yokes. All told, your truck should run perfectly square, if you are careful with your measurements and your machining. It is well after drilling the swing bolster in the center for a $\frac{1}{4}$ " pin, that you make a collar about $\frac{7}{8}$ " long to go on this pin. The reason for this is, that we put a cotter pin in the bottom of the king pin to hold the pilot truck on the engine when lifted, and it makes it much easier to take the pilot truck off the engine when this cotter pin is in a low position. It may be necessary after you assemble your chassis and level up your engine, to put a small washer on the top of the swing bolster to get proper height. Normally, it should come out all right, if you follow the measurements in the drawing.

The wheels of the engine truck can be turned on your stud arbor as explained in the section pertaining to Bettendorf trucks.



Quartering Wheels

Chassis

The chassis frame should be made of two pieces of $\frac{3}{8}$ " x 2" hot rolled steel 19 $\frac{1}{8}$ " long. These two pieces of steel should be fastened together by means of drilling one or two of your end holes, which you will use later, these holes being for 6/40 bolts. After these pieces have been fastened together, lay out your pedestal openings, your equalizer openings, and the profile cut out as shown in the plan for the wheels and bumper beam. The driving wheel pedestals should be absolutely parallel and square, as this is quite necessary in later quartering of your wheels. The bumper beam, the driving wheels, and cylinders, are all standard castings, also the axle pump block, which is made from a piece of bronze. The drawing tells the story very clearly as to your dimensions in spring work and holes to be drilled; therefore, I do not consider it necessary to go into too much detail on this part. However, when fastening these side frames to your bumper beam and your rear cross member, you should be sure that your driving wheel pedestals are absolutely square with each other. The frame, as you see, has four supports to keep it square, namely, the bumper beam, the front truck pin plate between the cylinder, the pump block, and the rear separating member.

Your main axles are made from 11/16" drill rod with a 9/16" shoulder to go through your axle box and a 1/2" shoulder on the end to carry your wheel. Whereas you will ream the drive wheel hole to 1/2", it is well to allow .0015 push fit on the drive wheel shoulder. The crank pins are made of 5/8" drill rod, both having a 1/2" .0015 oversize shoulder to push into the wheel, and the rear one having a second 1/2" shoulder to carry the main rod, also a 3/8" shoulder to carry your eccentric crank. These driving wheels may be turned on your stud arbor, which you have made for previous wheel turning, but you will have to make a 1/16" collar to fit this arbor to bring it up from 3/8" to 1/2" O. D. Go through the same procedure on your drive wheels as explained on previous wheels.

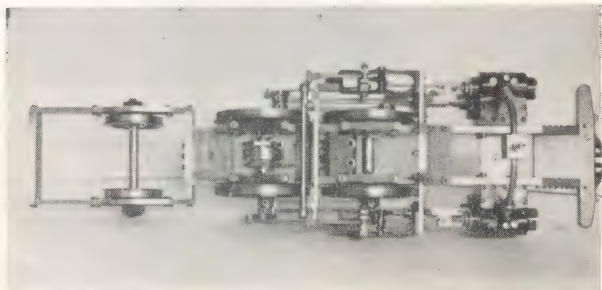
After the driving wheels have been turned and completed in accordance with the plan, then comes drilling for your crank pins. This should be done on a jig, by inserting a $\frac{1}{2}$ " pin in a heavy plate, setting this plate off center on your drill press $\frac{7}{8}$ ", placing a center drill in your drill chuck, center drilling each one of the driving wheels first. Follow this with possibly a $\frac{1}{4}$ " drill, and then add to your drilling, until you come up to your $\frac{1}{2}$ " reamer drill. The wheel, of course, should be clamped down on this plate when drilling and reaming, so that it will remain true. You now will have all your crank pin holes exactly $\frac{7}{8}$ " off center for a $1\frac{3}{4}$ " piston stroke.

Before pushing your wheels on the axle, be sure first to push your crank pins home, then comes the job of quartering. This is probably the simplest way to do it. Turn two soft centers for your lathe. One is to go in your head stock chuck and another in the tail stock or tail stock chuck. The head stock center is exactly $9/16$ " O. D., and the tail stock center is .001 under $\frac{1}{2}$ " O. D. Now, push one drive wheel home on your axle, as this wheel will not have to move again. Be careful and do not forget to put on your driving wheel journal boxes before you put on the second wheel, also you have two eccentrics which will slip on the main axle before assembling, which operate your axle pump. Now, after placing your second box on, start your wheel on by hand pushing it possibly $\frac{1}{8}$ " on your axle; place this assembly on your lathe centers. You will note why the tail stock center is .001 under size, as it has to slip into the wheel hole. Now, use a good heavy parallel bar or a good piece of c.r. steel across your ways near your headstock. Taking a good accurate machinists square, then turn the crank pin in the vertical position, bringing it up against your square and your center carefully, so as not to dislocate your square. Next, take an indicator, fasten it on the tool post, pick up the dimension of the top of the tail stock center on your indicator, roll the indicator out until it touches the top of the crank pin. This dimension at first hand should be fairly close, then, turn the drive wheel as-

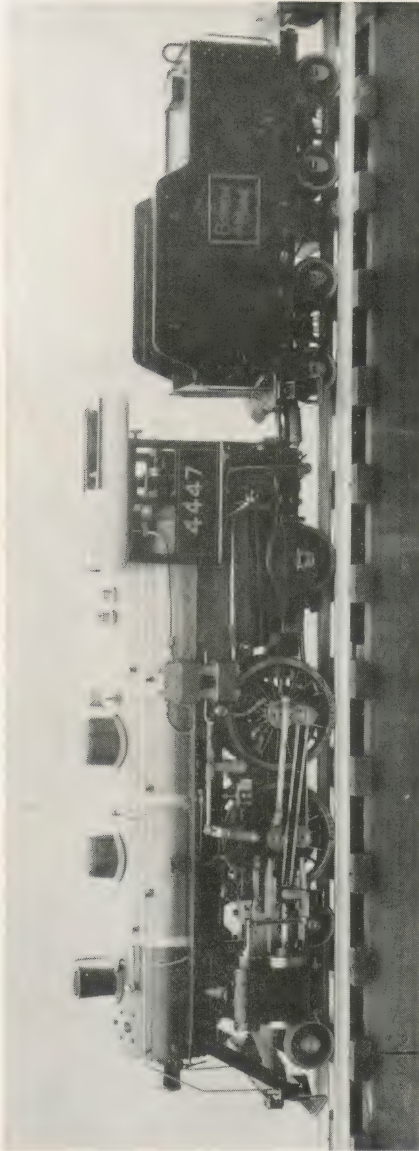
sembly by hand, either forward or backward to the downward quartering position. Place the square against the crank pin and center, then, follow again with another tail stock reading. If these are within .001 or .002, it is safe to push your wheel on another $\frac{1}{8}$ ". Keep repeating this process until you have pushed the wheel all the way home. It is well to drive a pin in your axle-wheel joint after this process has been completed. This will surely lock the wheels where you have finally set them. Do not put a screw in this joint and cut it off, as some day in the future, you may want to pull the wheels off.

The axle pump is made of a block of bronze, and in this case, uses a stainless steel $\frac{1}{2}$ " plunger with a $\frac{5}{8}$ "—27 gland nut. The plunger should have a $\frac{11}{16}$ " stroke. Be careful when setting this pump up, and making the eccentric straps, that the plunger makes all of its stroke forward; you must not let any air remain in between the end of the plunger and the end of the bored hole in which it slides.

The pump straps are of cast bronze. Another point which one should be very careful about, in making the axle pump, is that the lift of the ball should at no time be any more than $\frac{1}{32}$ ". This will insure perfect action in the pump. You will note that the spring equalization is of the simplest type, and very readily understood by viewing the plan, and is within the scope of any small home shop equipment.



Top View



Left Side View of Atlantic Model as built by a
New England Live Steam Member

Axle Pump

You recall on the previous page I mentioned slipping two eccentric cams on your main axle. These cams are to drive your axle pump, one of the most important accessories to your engine. When a steam engine needs water, it is very important to have a positive means with which to give it water. Our experience has proved that the axle pump is the most reliable pump to supply your engine with water and to hydro test your boiler from time to time as you deem it necessary. The axle pump as a rule runs on your main driving wheel axle with the pump block fastened behind your front driving wheel axle.

This block is a bronze casting, squared off in your shaper to fit in between your chassis steel or if you do not possess a shaper, it may be turned on a lathe in your four jaw chuck, being sure you turn it square. Following this, you put the block on your layout table and lay out the face which accepts the ram or rear face.

First, put a vertical line in the center. Then set your dividers to $\frac{1}{2}$ ". Place one point of the divider on the center line scratching on each side which will give you a center to center distance of 1". Then, from the bottom of the block set your square at $\frac{3}{4}$ " and describe a short line across these two previous lines. Prick point these two points rather heavily. Now, put the block back in your four jaw chuck bringing your tail stock center into one of these punch marks. Adjust the jaws of your chuck so that they do not throw this block out of the position in which the tail stock center is holding it. Drill the ram hole with a $\frac{3}{8}$ " drill to the depth indicated on the blue print. Put a boring bar in your tool post and bore the hole to exactly $\frac{7}{16}$, preferably boring the hole to the exact thumb fit of your $\frac{7}{16}$ stainless steel ram. When this is completed and you have the bottom of the hole squared off, then bore for your $\frac{5}{8}$ - 27 tap thread which holds your gland nut. This thread can be chased part way or all the way, then run the tap in for the last chasing to bring it to size as the thread must be

perfectly true with your ram hole. Repeat this procedure in the opposite hole.

Lay out the two holes in the top of the block which eventually take the pipe fittings and stainless steel balls. Drill right straight through the block with a No. 16 drill. Follow it with a drill to take $\frac{3}{8}$ - 24 S. A. E. thread. This thread should be run down with $\frac{1}{8}$ " of the bottom of the hole, as indicated on the blue print. Do the same with the bottom of the block. Make your fittings screw down against these stainless steel balls. Place your $\frac{1}{4}$ " ball in the hole, and make the fitting so that the ball has exactly $\frac{1}{32}$ lift—no more. This should be the same in the bottom as in the top.

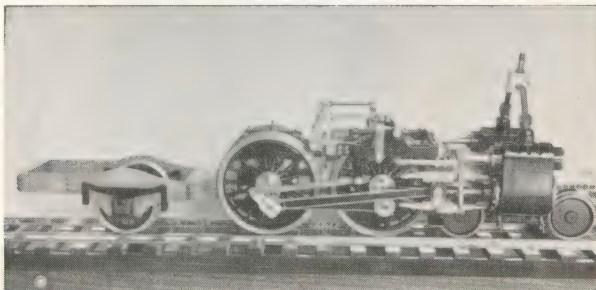
The $\frac{3}{8}$ " holes in the bottom of your pump block will have to be castilated so that as the ball lifts, water will pass through the little ridges made by a very small chisel which appear like a castilated nut. The top screw fitting should be castilated the same as the casting in the bottom. You will also note that you will have to cross bore a hole through these two top fittings after they have been put in place, plugging the hole on the outside of the block. This is so that the pumped water will pass through both hole outlets. You will note the stainless steel plunger must be slotted and drilled with $\frac{3}{16}$ " hole for a pin which carries the eccentric straps. The eccentric straps are very simple to make. File up your casting face, hacksaw it in two pieces, then smooth your hacksaw marks. Drill two holes in the wings of the pump eccentric straps for two 6-40 bolts.

After putting it together again, strap it to your face plate or grip it again in your four jaw chuck and turn it to the size of the eccentric on your main axle. When this axle pump has been completed, it should be fastened in between your chassis steel with four 8-32 hex cap screws. This block also makes a fine steadying member of your chassis sides.

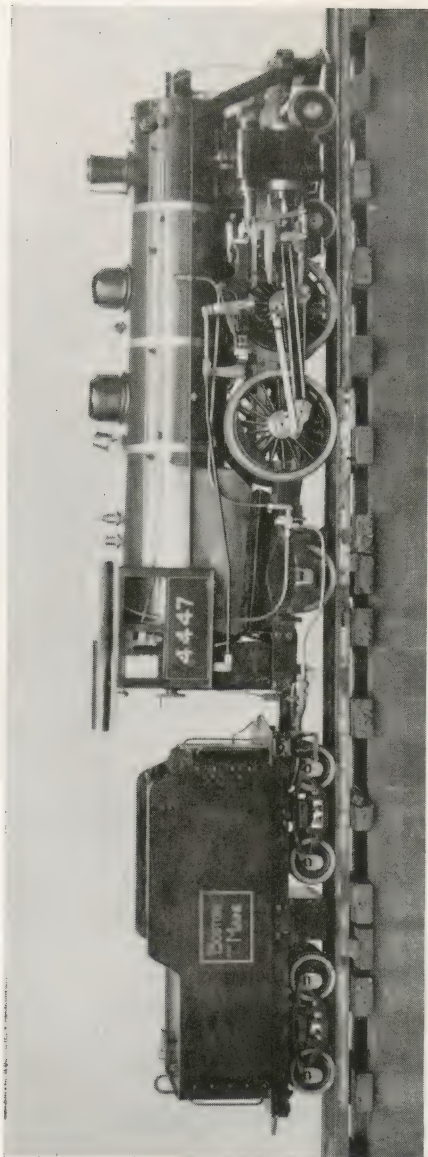
Two Wheel Trailing Truck As Simplified

We first start out with the front end beam which is $1\frac{1}{8}" \times \frac{3}{8}" \times 4\frac{1}{2}"$ long. This is the section which fastens on to the rear of your engine chassis main frames, as you will note on the print. Next, cut two side pieces following the general profile of the drawing $\frac{1}{4}" \times 2\frac{3}{4}" \times 8-5/16"$ long. Then, your rear beam or cross member $\frac{3}{8}" \times \frac{3}{4}" \times 4\frac{1}{2}"$ long. All of this is to be bolted together very firmly using angles on the inside to stiffen your square joints. We do not attempt to carry very much weight on this trailer truck. It is used more or less as a balancing weight on wheels to keep the engine steady and to keep it from bobbing. As before stated, we try to get as near as possible all the weight of the engine on the drive wheels.

The journal boxes are of cast iron or bronze as you wish, and may be milled with a bearing only on the inside or as you notice on the drawing with a $\frac{1}{4}"$ slot. Do not have these boxes fit into your side frame members tightly. It is a big error to have too close a fit, particularly for side motion in journal boxes of a locomotive. It is best to have a little sloppy side action to make the engine work well. The wheels used on this truck are finished on your stud arbor, the same as previously explained, pushed on to $\frac{1}{2}"$ axle with flanges $3-9/32$ back to back. This particular wheel is a 3" spoked wheel which is proper for the engine.



Side Elevation



Right Side View of Atlantic $\frac{3}{4}$ " Model

Cylinders and Valves

Diameter $1\frac{3}{8}$ " Stroke $1\frac{3}{4}$ " Valve Travel $7/16$ "

The cylinders used on this engine are what we call a two piece type. Cylinder section being on the bottom, steam chest on the top, and it uses a flat valve. When construction is finished, it has the appearance of a piston valve type combination on the outside.

The cylinder block should be put in your four jaw chuck on the lathe, or if you have a shaper, clamp it in the shaper vise, squaring off the top face and the inside face, which fastens on to the frame with only a rough chip. When this is completed you now have two square edges to measure from.

The cylinder can be bored in a four jaw lathe chuck, or fasten the cylinder to your compound table and use a boring bar between lathe centers for boring. You can choose whichever is the easiest. The cylinder should be bored to about .003 under size of $1\frac{3}{8}$ ". Then, this should be taken to the bench and ream the hole very carefully and slowly by hand. Now, that you have your cylinder hole completed, you can start laying out the different faces from the cylinder hole center line. For instance, from the center of the cylinder, to the chassis frame, it should be $1\frac{3}{8}$ ". Also, from the center of the cylinder, to the top valve face, it should be $1\frac{1}{8}$ ". With these laid out, you can put them back into your four jaw chuck or shaper vise, machining these two surfaces to be exactly parallel with your cylinder hole and square with each other. With these complete, slip your cylinder on to an arbor and face off both ends to take the back and front cylinder heads.

Now, for a good careful layout job of the steam and exhaust ports. Place the cylinder in the vise and apply to the top face blue Vitrol, or any other layout compound you have. Then, after this is dry, lay out your exhaust and steam ports following the blue print carefully. Then, place the cylinder block in the milling vise and mill out your exhaust and steam ports in accordance with the blue print.

3/16 212 1311
10 36 1340
15
If you do not have a milling cutter which reaches down 3/16" deep, you can use a small end mill in your drill press to make the ports deeper, but be sure not to injure the sides of your ports. Drill your exhaust passage according to the plan and your steam passages from each end of your cylinder toward the center in accordance with the cross section plan.

You will note by the blue print that the cylinders are fastened to the chassis frame, each with 8 - 10/32 hex screws. Use a template to drill for these screws. First mark the cylinder face. Then, center the template on the chassis side and mark it.

In turning the rear cylinder head, bore and tap for the gland nut, also drill and ream for the piston rod in the same operation so that the hole for the piston rod will be exactly in alignment with the facing of the cover and the piston hole.

The steam chest is machined the same way. Face off the bottom and the inner side which rests against the boiler saddle. You will note this steam chest is fastened to the cylinder with a set of 5-40 fluster head screws, which if you cannot purchase, you will have to manufacture yourself, because of the length.

The steam chest heads are relatively simple, one can follow the plan readily in constructing them.

The valve and valve nut is easily explained on the blue print, and should be made of bronze, so that it won't rust and stick to the valve port face of the cylinder when the engine is in the shop.

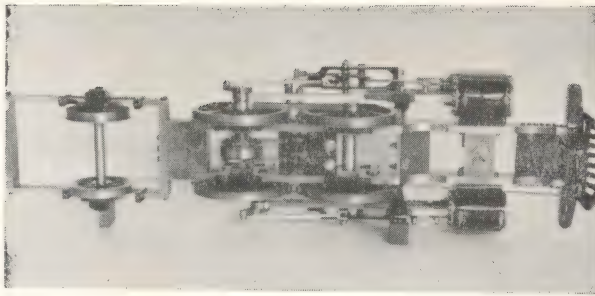
The piston you will notice is of cast iron, with 2 - 1/8" ring slots equally spaced and 1/8" deep. These slots should be a good fit to the ring. The piston about .001 smaller than the cylinder hole.

The crosshead is made of a piece of steel with bronze crosshead shoes bolted to it. The crosshead guides are made of c.r. steel fastened to the rear cylinder head with 2 - 5/40" screws, top and bottom. The crosshead guides are held at

the rear end by a crosshead guide hanger which attaches to the Baker gear frame above it.

You will note that the $\frac{3}{8}$ " exhaust passage comes through the chassis frame, both exhaust pipes and are cut on a bevel, welded together into one pipe with the exhaust nozzle setting on the top of it. There are two flanges welded on the lower ends which bolt to the chassis frame.

The valve rod and piston rod should both be of stainless steel material.



Bottom View

Baker Gear and Timing

Several different valve gears are used on Atlantic type engines. I chose the Baker as being the simplest for the average craftsman to build, also castings are available for the bell crank and gear connecting rods and reverse yoke, which save a considerable amount of work.

I have said many times, that the Baker gear is the best gear. Of course, that comment is open for discussion. My reason for saying that, is that all parts are bushed with standard bunting bushings, result is that new bushings can be pushed into place when the old bushings become worn, thereby tightening the gear up to its original manufactured tightness.

The front gear support is a piece of $3/16''$ x $1''$ angle iron $8''$ long, cut out in accordance with the plan and fastened to the chassis frame, $2\frac{5}{8}''$ ahead of the front drive wheel center line.

The rear gear support is made from a piece of $3/16''$ x $3/4''$ bar stock $10\frac{3}{4}''$ long. This is shaped to set upon the brackets which show in the plan to carry the rear of your Baker gear frame. The gear frame itself, is a left and right bronze casting.

These side gear frame castings are rivetted together with a spacer between them to give the proper space of $7/8''$ inside the frame, then fastened to the front and rear gear support. After these sides have been rivetted together nice and square, you can lay out the axis centers of the Baker gear, on both frames. Drill and ream carefully, pushing in bushings if you wish to be that fussy.

The bell crank is a bronze casting which needs no bushings. The reverse yoke is bushed on the bottom, and also the radius bars are bushed both top and bottom, with a $3/16''$ standard bunting bushing. All the pins of this gear should be hardened and made from drill rod. The gear connecting rod is a bronze casting and requires no bushing.

The combination lever is a $3/16''$ x $1/4''$ steel, and because of its fast travel, should be hardened. The reverse

arm reach rod and valve rod are made from c. r. steel and need not be bushed as their action does not require it.

The timing of this engine is quite a bag of tricks after this assembly has all been completed. The eccentric rod in no instance should be made until the timing has been done. It has always been customary, to make a slip joint temporary eccentric rod to use while timing, then, when the length is determined by this operation make your permanent eccentric rod.

We will now follow the standard timing rules.

TIMING BAKER GEAR

1. Block up wheels in running position.
2. Get front and back dead centers on crosshead and mark these positions on crosshead guide with fine scratch line. (This measurement should be obtained by turning drive wheels by hand. Always turn in same direction.)
3. Make two dummy pins, one for gear connecting rod lower pin hole and one for eccentric crank pin hole, these pins to have a small No. 60 drill hole in center for dividers.
4. Set gear connecting rod in mid-position so that reverse yoke swings back and forth without moving bell crank.
5. Use a pair of dividers. Set piston on front dead center (by turning drive wheels). Measure from center of pin in gear connecting rod to center of pin in eccentric crank. Do the same thing with piston on back dead center. Move eccentric crank until both positions are the same measurement.
6. To check this measurement of eccentric rod, set crosshead on front dead center. Move reverse yoke back and forth. Valve should NOT move. The same for back dead center.
7. Now set valve on valve rod adjustment to have equal leads on front and back dead centers when reverse yoke is in mid gear.

After completing this, and giving the engine a test, using your temporary slip joint eccentric rod, then make your permanent eccentric rod.

Smoke Box and Boiler

The smoke box is the first piece to be constructed and is a copper tube $5\frac{1}{8}$ " O. D. with $\frac{1}{8}$ " wall, $4\frac{1}{2}$ " long. This sets upon the conventional boiler saddle $1\frac{1}{4}$ " above the chassis. You should follow the side and end elevation print for setting this on the saddle. At the same time, machine the smoke stack which is taken from a casting, and which rises $1\frac{3}{4}$ " above the smoke box, with a tubing flared out eight degrees on the bottom for a $\frac{1}{2}$ ". This is pressed up into the stack. The stack is fastened to the smoke box $2\frac{1}{2}$ " from front of smoke box to the center of stack, with $8\text{-}3/48$ Hex cap screws.

Boiler construction is a trick unto itself and goes along, in many instances, faster than machine work. If we were to follow out exact scale, the boiler should be $4\frac{3}{8}$ " in diameter, but because I like a husky boiler and one that steams well, I decided, as many others did, to make a $4\frac{7}{8}$ " I. D. boiler, which in reality is a $5\frac{1}{8}$ " O. D. I think this should be a copper boiler.

Next, comes the exhaust nozzle which sets upon the top of the $\frac{3}{8}$ " exhaust tube and is built so that you can change the size of the nozzle as you experiment. Use a $\frac{1}{4}$ " opening in the nozzle first in accordance with the expansion rules of 1" to 6". The steam should expand properly to create a perfect vacuum two-thirds of the distance up this stack. At the same time, drill a $\frac{3}{8}$ " hole in the top of the smoke box, $1\frac{3}{8}$ " back of stack center line, to take the relief or drifting valve.

The main boiler shell is made from a $5\frac{1}{8}$ " tube, and is 19" long. Make a wooden plug for each end of the tube, push them in the tube, then place this assembly on your lathe centers, set a tool in the tool post and drag the tool horizontally along the tube. Then, turn the tube over $\frac{1}{4}$ turn, repeat this operation until you have four equally quartered lines.

Take this out of the lathe and knock out the wooden plugs. Now, put the tube on the bench and lay out all cuts

1/8" PIPE THREAD
1/4" DRILL

and drilled holes on the tube in accordance with the plan. Place the tube in the vise and cut to the center line 12" from front end. This part is to be flared out for the outside of the fire box. It would be well before flaring out this tubing, to put the tube into your furnace and heat until the tube becomes red. Take it out, quench it in water. Now, it should be perfectly annealed. Then, flare out the rear of the tube for your fire box to the shape on the blue print. Cut off the rear end of the tube to the angle and dimensions on the plan, or a 1" taper bottom to top.

Following the forming of your fire box comes the front fire box throat sheet. This will necessarily have to be taken from a sheet of copper about $6\frac{1}{2}$ " wide by 6" high, and should be cut in a profile to fit the round of your $5\frac{1}{2}$ " tube on top, and the flare of your fire box on the sides. I like to cut out cardboard patterns before forming these sheets as it makes it much simpler. With this piece annealed, place it over a hard wood block properly shaped with your cardboard pattern and turn the edges over $\frac{1}{4}$ " to $5/16$ ". Be careful to maintain a square edge on the bottom of the sheets when forming them so that you can always check your angle or degree of taper in the fire box. Now, with this piece formed and clamped onto the edges of your fire box, you will begin to see the boiler taking its normal shape. Do not forget to drill a $\frac{1}{2}$ " hole in this throat sheet for your boiler drain cock button which should be tapped with a $\frac{1}{8}$ " pipe thread.

Next, I think it is best to start shaping the sides and top of the inside of your fire box. You will note by the blue print that the crown sheet tapers back toward the rear. The reason for this is to keep the back of the crown sheet covered with water when the engine is on a grade. You will need a sheet of copper about $6\frac{1}{2}$ " x 15" with which to make your fire box sides and crown sheet. Again, this should be annealed. Follow the angle and measurements on the blue print. Onto this piece, which you have just shaped, you will next get ready to place the back tube sheet. This should be formed over a hard wood block.

3/8" DRILL
10-32 T&D

10-32 EVERDOR SCREW

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With the cardboard pattern, lay out your 31-3/8" tube centers and drill them for a nice tube push fit. Do not get too close to the edges of the back tube sheet with your tubes, as you will have difficulty in welding the tubes or replacing the tubes later when repair is necessary.

In drilling the centers of the back tube sheet or for the front tube sheet, use the same pattern. This back tube sheet can be rivetted to the smoke box sides with a few rivets to hold it in place. Form the fire box back head in accordance with the plan, cutting your hole for the fire door as you make it. The girders on top of the crown sheet can be made of 1/16 copper rivetted together, or heavier, if you have it, and rivetted to the crown sheet before you place this assembly into your boiler shell.

Now, comes the boiler back head which of course is simple when you see the plan. It has a 1/8" pipe thread bushing in the top of the back head, and also another 1/8" pipe thread bushing in the top of the boiler shell for a water fitting.

Next, comes the front tube sheet, which I previously mentioned should be drilled in accordance with your paper pattern used on the front of your fire box with the exception of one extra hole tapped 3/4" from the top, for your dry pipe connection. You will note the steam dome rises up about 1" from the top of the boiler to allow the stand pipe to pick up dry steam and that your throttle fastens onto the front of your dry pipe. Two safety valve bushings should be welded on the top of the shell with a 1/8" pipe thread in each. Also, a button tapped 10-32 to hold the sand dome.

The mud ring is made up of 3 1/8" pieces of scrap from your boiler or a 3/8" square piece of copper rivetted on to the fire box lightly, and then brazed into place. There should be a 5/16" square grate support on both front and rear of the fire box. Stay bolts on all sides of the fire box should not be at any time, more than 3/4" on centers, using either solid 3/16" copper stay bolts welded on both ends or a 10-32 Everdor screw welded on both ends. The back head

and the front throat sheet should be stay bolted as the blueprint shows. It is well in setting in the mud ring to place it above the edge of your fire box sides and end sheets perhaps $1/16$ of an inch so that when you turn the boiler upside down to braze it, you will have a chance to put a small puddle of brazing metal on this so-called upset to make a good joint. In placing your tubes in the back and front tube sheet, they should be cut off so that they stick out on both ends at least $1/8$ ". This makes for much easier silver soldering or brazing. You will also note that there are 2 $3/16$ " stay rods going from the back head to the front head. These are to help hold some of the expansion which takes place in this area.

I need not elaborate on the fire door as each builder has his own ideas. Some like to make a butterfly door, others, a straight hinge door, and others, a sliding door. Whichever it may be, it is a very easy matter to weld on a couple of buttons after the door ring has been welded in. If you wish to plan for a bracket to carry the throttle, you may apply that at this time. The top center pipe fitting on the rear of the boiler can be used for a turret. Also, it can be used for your whistle mount or any other accessories you may wish to add to this engine. Top water glass fitting **not to be used** for anything else.

The top nut of your water glass should be set so that it is about $11\frac{1}{2}$ " above the top of your crown sheet. The top of your bottom nut should be about level with your crown sheet. This will give you a positive low reading mark which you must never go below with your water level. Do not use a water glass any smaller than $3/8$ " O. D. You will find smaller glasses than this give you too many bubbles and will give you an untrue water reading.

You will note your steam dome is made of a piece of copper tube 2" in diameter with a $1/4$ " wall about $1\frac{1}{8}$ " high and welded on. It is well to make this a large opening so that when future washing of the boiler takes place, you will have ample chance to force water in and out of the boiler.

Grates are made of $\frac{1}{8}$ " x $\frac{3}{8}$ " c. r. steel, unless you want to be real fussy and use chrome nickled steel, which of course, is the best. You will get no oxidization with the latter material. These $\frac{1}{8}$ " nickel bars are buttoned together with three rods, with $\frac{3}{16}$ " spacers between the bars, and the grates are made in three sections, so that they may be taken out of the fire box through the fire door.

After the boiler has been welded together nicely, put plugs in all the pipe outlets. Then, properly hydro-test it. (Caution—do not by any means test by air pressure.) When you have picked up all your weeps and small leaks, next, comes the lagging of this boiler before fastening it to the chassis. The lagging is of course another simple job when you see how it is done.

Take ordinary plumbers' asbestos pipe covering $\frac{1}{8}$ " thick, moisten it a little for ease in curling it on to your tube, wrap it around your boiler tube, using ordinary household thread to hold it in place. It is well to put on up to four thicknesses over your fire box and boiler tube as far forward as the steam dome, taper this covering down to nothing on the front edge of the boiler. We hold this lagging in place with what is called Russian iron, or ordinary blue stove pipe iron, cut in three sections, the joints between these sections are covered by a $\frac{1}{4}$ " band, with a screw tightening up joint underneath the boiler.

You will note from the blue print that the boiler is fastened to the smoke box with round head screws or rivets, and the smoke box to the saddle with hex head bolts. Use a hinged joint at the front end of your fire box to fasten the boiler to your chassis. This joint gives the boiler a chance to move back and forth as the boiler expands and contracts. At the rear of your fire box, you will also note another expansion support or plate made of $\frac{1}{32}$ " brass sheet. These are all the supports you need to hold your boiler in place on your chassis.

Oscillating Disc Throttle

(For 5" or 5½" Boiler)

There are many types of throttles, but of the front end throttle, I like this one best.

My reason for liking it, is that the bobbin or throat valve is held against its operating face with the steam pressure from the boiler on the bobbin side. We start out first with a bronze casting and a blue print which covers the construction of this throttle.

The first and most important part of the machining is the boring for the throttle bobbin or disc which means we clamp the throttle bronze block in a four jaw chuck and bore a 1" hole 1½" deep, finishing the bottom face very carefully, and with a fine cutting speed. Take a 1/8 center drill and drill a center pivoting point for this disc 1/16 deep. Next, face off the outer end of the casting and chase a 1 1/16 - 40 thread about 3/8" deep in this hole just bored. Take the block out of the chuck and drill all pipe holes, two in the bottom, one in the rear, and then drill a 5/16" hole in the bottom face, (which your disc turns against), in the pipe hole on the left side. Do not forget your connecting pipe hole which shows in your cross section blue print which is 3/8" from the bottom of your casting.

Your bobbin or disc should be turned in accordance to the blue print, and should be made of stainless steel.

The gland nut and large house nut which holds the bobbin in can be made of brass. It is well to turn the large housing nut by chasing a 1 1/16" x 40 thread, all in one operation boring for the throttle rod at the same time.

The spring which holds the bobbin against its face can be made of stainless steel, bronze wire, or cadmium plated. The throttle bobbin rod is of stainless steel and should be flattened on one end and slipped through the gland nut and spring, and allowed to enter the bobbin with a very careful slip fit. In other words, the bobbin should have ease of movement on the throttle rod.

After the rod is put in place, there should be a small

hole drilled, and a thirty-second pin placed in the hole right behind the large housing nut to keep the throttle rod from working out of the bobbin.

The crank arm on the outside is made of ordinary c. r. steel. The relief or drifting valve enters the throttle block through a hole which is drilled from the top of the smoke box. This valve can have a $\frac{1}{8}$ " hole drilled into the valve chamber. There should be a hole drilled with correct angle of the smoke box, for the throttle rod exit and a small plate fitted around the rod to keep this tight as you must not have any leaks in your smoke box to interfere with the vacuum.

It is always well to test these things, like a throttle, before you put it into the engine by taking a bicycle pump or air pressure if you have it, and place the throttle in a bucket of water to see how good a machine job you did. Of course, you will have to plug up the pipe exit holes you are not using.



Yankee Shop Interior

